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VANCOUVER BOARD OF TRADE.

BULLETIN No. 1.

Iron in British Columbia

Being information collected and collated by the Vancouver Board of Trade dealing with the Iron Industry in British Columbia.

VANCOUVER, B. C.
1918

Price Twenty-Five Cents.

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Iron in British Columbia.

Address delivered by Mr. Nichol Thompson at a luncheon given at the Hotel Vancouver, on Monday, the 14th day of January, 1918, by the Council of the Vancouver Board of Trade to the following members elect to the Dominion House of Commons: Messrs. H. H. Stevens, Vancouver Centre; S. J. Crowe, Burrard; Major Cooper, Vancouver South; H. S. Clements, Comox-Alberni; W. G. McQuarrie, New Westminster City; and F. B. Stacey, New Westminster District.

Mr. President,—

I esteem it a very high honor to be asked to present the Board's memorandum on the importance of the establishment of blast furnaces and the making of pig iron from our native ores to the members of Parliament elect. This is the first time in my experience, extending over twenty-five years that the business men of the city represented by the Board of Trade and the Members of Parliament as representatives of the people, have met in a business way to discuss and exchange views on the best means to be taken to develop the resources of the Province for the general good. It is a good omen, and I trust marks an epoch in the history of our country, and is an earnest that the men whom we have recently elected and who may be elected in the future, are truly representatives of the people, and not merely hired delegates of any political party.

Speaking of the memorandum which has been so ably prepared by the Secretary and his staff, it might be described as a comprehensive compilation of the varied opinions of Government officials, members of the Dominion Geological Staff and abstracts from the annual report of the Minister of Mines, as compiled by the Provincial Mineralogist, and reports of the Mining Committee of the Board of Trade, none of which, I regret to say, are of very much use to anyone desirous of investing capital in the iron and steel industry in our Province. Take the latest production as a sample, issued by the Mines Branch of the Department of Mines, Ottawa, and entitled: "Iron Ore Occurrences in Canada," in two volumes, compiled by E. Lindeman, M. E., and D. L. Bolton, M.A.B.Sc., with an introductory by A. H. A. Robinson, B.A.Sc. This report refers to only two properties—the Puget Sound Iron Company's property on Texada Island and the Glen Iron Mine near Kamloops. The only reason why these two properties are always chosen as representing the iron ore deposits of B. C. is perhaps the fact that, with the exception of a few tons shipped from Redonda Island, they are the only deposits from which considerable tonnage has been shipped.

As a matter of fact from a practical blastfurnace standpoint the two properties mentioned are the least desirable of any of the known deposits, from the fact that the sulphur content in the Texada ore especially, is very high, which necessitates roasting before smelting, some of the lenses carrying as high as .30 per cent. of copper. Notwithstanding this, however, it is admitted that there is a very large deposit of high grade magnetite, estimates of the tonnage varying according to the opinion of the expert from 4,500,000 tons to 20,000,000 tons, while, according to W. M. Brewer, M. E., who spent the summer of 1916 in examining iron properties for the Provincial Government, the total tonnage of actual probable and possible iron ore on Vancouver Island and adjacent islands, is only 12,888,200 tons. In the face of all this conflicting expert opinion it is very evident that some other and more reliable means of determining the extent and value of our iron deposits must be found before real capital can be induced to come and establish the industry. The necessity for this is so patent that it seems almost superflous to refer to it. Never a day passes but I get some kind of an enquiry regarding this industry in some shape or other.

As stated in the preface of the memorandum, Hamilton pig iron costs, delivered in Vancouver, $69 per ton. I have no hesitation in making the statement that, even with the present high wages and cost of coke and other materials entering into the manufacture, good foundry pig iron could be made from our own ores, and a good profit realized therefrom, at $35.00 per ton. This means a saving of 100 per cent. on all castings entering into the production of our various foundries and machine shops. The market for foundry pig iron in B. C. is at least 10,000 tons per year, and will be considerably increased by the shipbuilding industry, which we now hope has come to stay, and herein lies the crux of the question under consideration today.

Iron and steel forms the basis of all industry, and in future the nation who possesses in greatest abundance the natural resources in coal, iron and copper, will control the destinies of the world. The present war has demonstrated this beyond any doubt, and it goes without saying that if France could once more dominate with her guns the iron ore fields of Lorraine, the war would be over in a month. Out of 28,607,000 tons of iron ore which Germany extracted from her soil in 1913, 21,135,000 tons came from the formerly French fields of Lorraine annexed in 1871. Bismarck's surveyors made a mistake in putting the boundary line about five miles east of Briery, and left France with half the iron ore fields, yet from the half she gained, Germany extracted 21,000,000 tons in 1913. France concentrated in the half remaining to her eight-tenths of her metallurgical power, and that power passed to the Germans with their conquest of north-west France in 1915.

In 1913 Germany bought from abroad 14,191,000 tons of iron ore, and this supply is practically cut off now, but, instead, she has the supplies from French Lorraine, and, with these supplies in her hands, her output of munitions can be kept up as long as she has the man power to work the mines and turn the ore into steel. What the loss of these iron ore fields and metallurgical works have meant to France may be imagined from the fact that she has been deprived of 90 per cent. of her iron ore, 68 per cent. of her coal, 66 per cent. of her pig iron, 76 per cent. of her steel and 76 per cent. of her wrought iron. Out of 127 blast furnaces working in 1913, 95 are now in the power of Germany, and had it not been for the fact that Great Britain had the courage to fall back on her long discarded deposits of low grade ore, and turn the whole nation into one huge munition plant, in addition to the millions of tons purchased from the United States and Canada, France would have been wiped off the map, and Great Britain would be in the hands of Germany today.

Do not let us therefore deceive ourselves with reference to the necessity of conserving our natural resources of coal and iron. In 1912 Sir John Thornycroft, speaking before the Dominions Royal Commission, said Great Britain imported 6,000,000 tons of iron ore per year and at the then rate of consumption, the hematite ores of Spain would not last more than 25 years. It is also estimated on the best authority that the known deposits of hematite in the United States are being seriously depleted, and will be practically exhausted in the next 25 or 30 years, and that the harder deposits of magnetite in Canada will become more valuable on that account.

The production of pig iron in the United States increased from 8,000,000 tons in 1896 to over 37,000,000 in 1915, and the total shipments from the mines in the United States in 1915 were estimated to have exceeded 55,000,000 tons, an increase over the previous year of 38 per cent. In 1915 Great Britain imported from the States 20,000 tons of steel billets valued at $11,000,000. According to the monthly report issued on January 10th, the unfilled orders of the United States Steel Corporation on December 31st amounted to 9,381,718 tons, an increase of 484,612 tons compared with the orders on November 30th, and, according to Chairman Hurley, of the Shipping Board, the production of ship tonnage in the United States in 1918 is estimated at from 4,500,000 to 5,000,000.

There are now 118 shipyards in the States, 51 of which are turning out steel ships, and the forces of shipyard workers had increased from 105,000 in October to 150,000 in December. From these figures it is evident the demand for pig iron and finished steel will increase, and the only possible chance for steel shipbuilding to become a permanent industry in British Columbia is the establishing of a steel industry in the Province. The Provincial Government should put a reserve on all deposits not Crown granted and if deemed necessary even purchase from the present owners. Suitable deposits could then be leased to anyone who will establish the industry, on a reasonable royalty basis, and the Province would thereby reap the benefit which would otherwise go to the speculative owner.

PREFACE.

In the Year Book of British Columbia for 1914, Mr. R. E. Gosnell, the writer, says that the question is frequently asked if the economic conditions on the British Columbia coast are favorable to the development of an iron and steel industry. He goes on to say that there was a time when undoubtedly they were not, and it is pertinent to enquire if sufficient advancement has been made in Western Canada to justify the investment of capital in an enterprise which requires unusually large expenditure of capital in plant and operations, as compared with most other industries.

In the present year, 1918, there is no hesitation in saying that the economic conditions undoubtedly are favorable if for no other reason than the demand for iron and steel. There is not only an increased demand, but, owing to the lack of ships, it is more difficult to supply that demand, and the increase in railway rates adds considerably to the cost of material brought by that means. We have the market, and as to the cost of production, labor and fuel may be high, but it is certain that we should be able to produce for considerably less than the cost of importation.

It is well to mention here that Mr Nichol Thompson gives the following figures for January, 1918.

"Present price of pig iron delivered Vancouver is $69 per ton, and this is Eastern pig iron made in Hamilton, Ontario. Present railway freight on this iron is at least $18 per ton. We are not only met with this high railway freight but the consumption of iron ore in blast furnaces in Canada has increased so rapidly that in 1916 the total production of iron ore in Canada was only equal to 15.5 per cent. of the total ore smelted in Canadian blastfurnaces. In other words, practically 85 per cent of the iron ore used in the manufacture of pig iron in Eastern Canada is imported either from the Lake Superior iron ranges in the United States or from the Wabana deposits in Newfoundland."

And, dealing with the market, he further states: "That the imports of iron and steel into Canada show that the Canadian manufacturers have a large field yet to occupy. Unrevised trade returns show imports of approximately $20,000,000 of steel products, and 300,000 tons of pig iron of the value of approximately $4,000,000, and these imports are in quantity not far short of the entire present production of the Canadian plants, indicating ample field for growth; and as the cost of labor represents approximately 80 per cent. of the cost of manufacture of iron and steel, the above figures indicate that from $12,000,000 to $15,000,000 in wages was paid by Canada to foreign workmen for iron and steel imported, much of which ought to have gone to Canadian workmen. Consequently any large increase in the amount of iron and steel made in Canada would not only help the industry by reducing costs and providing an adequate return of capital to the encouragement of further development, but would build up industrial population in Canada by providing a large amount of well paid work now done for us abroad."

Strong arguments for an iron and steel industry on the Pacific Coast were submitted to the members of the Vancouver Chamber of Mines in an address given by Mr. B. L. Thane, of San Francisco, on the 31st January of this year.

At the present time from 1,250,000 to 1,500,000 tons of steel products are being used on the Pacific Coast, and this is shipped from the East; and the syndicate, of which he is a member, has come to the conclusion that a plant established on the Pacific Coast can control from 500,000 to 600,000 tons of this business. The balance, consisting of special sections of structural steel and rails, could not, in his opinion, be made at a price to compete succcesfully with the East at the present time, the machinery required for manufacture being very costly and the demand not sufficient to keep it employed.

However, they are so convinced that the time has arrived to take advantage of the market that offers, that they have been studying the iron ore deposits and the coking coals from Nome to Mexico, the former for two years and the latter for one year, to ascertain the most suitable materials for the production of pig iron of the required quality at the cheapest price.

The results of the work of fifteen men for those periods of time has been assembled and classified on one sheet of paper, and they are satisfied that they will be able to produce as cheaply as, and successfully compete with, the Eastern manufacturers to the extent mentioned above.

There is a large market for tin plate, and this is increasing, as the canning industry is extending all the time At present 140,000 tons per year is used on the coast and this is brought from Pennsylvania. In the past the tin plate used in the West was mostly imported from Wales. Galvanized iron also is in great demand and the zinc ores of the Province could be utilized in the production of this.

Another reason for locating a plant on this part of the Coast is one of shipping. Shipping is attracted to a point where it can get balanced trade. Ships that bring cargoes in want something to take away. On investigation they found that the proportion of exports to imports was at Los Angeles 17 per cent, San Francisco 35 per cent, and the Puget Sound and B. C. ports 67 per cent. There is also a balance of 400,000 tons of empty space in ships east bound, and a large trade is waiting for us in the Orient in addition to the steel products used on the Coast.

Then, again, steps should be taken to retain the skilled labor that has been brought to the coast to engage in building steel ships. When the submarine menace has been overcome and the volume of the world's tonnage restored, the extraordinary shipbuilding programme will be completed, and if a steel plant is here scores of industries would spring up as the labor would be here to establish them, and there is no reason why the coast should not become a great industrial centre.

It should be understood that Mr. Thane came to Vancouver on the invitation of the Vancouver Chamber of Mines as that body thought that the result of the investigations made by his syndicate would interest the mining men of this Province, and that he did not come to ask any assistance, financial or otherwise.

In his annual report for 1917 the Minister of Mines for the Province of British Columbia says:

"The past year has seen a great demand for iron and steel on the Pacific Coast, the normal demand having been greatly increased by the need for steel in shipbuilding and munitions work, while the usual outside sources have been monopolized by war needs in other parts of the world and the high freight rates have made the lack of local production more pronounced. Consequently, it has been strongly advocated in many quarters that the conditions are favorable for the establishment of an iron smelting plant somewhere on the British Columbia coast. So far nothing definite has materialized, although there is apparently a prospect of such a plant being established on this coast. As is well known, there is on the coast, in the aggregate, an adequate supply of magnetite iron ore, quite sufficiently free from impurities as to be within the Bessemer limit, to supply ore for such a plant."

As to the supply of iron ore, we as yet have no idea of the extent of this, but it will be seen from the following pages that we have, on the authority of mining engineers employed by the Dominion and Provincial Governments, a supply of actual ore and favorable indication of possible reserves. A great deal of this ore is extremely favorably situated for transportation, being on or very near the water. Most of it is magnetite, but the practical experience of the Irondale furnace is sufficient to prove that it can be treated in a satisfactory manner, and that it produces iron of a high Bessemer quality.

In regard to the supposed inaccessibility of the known deposits of hematite, some of these are reported within 100 miles of salt water transportation, while in Sweden the magnetite ores in many cases are brought 200 miles by rail and 800 miles by water with a further short rail journey at the other end, and it is not unusual for the charcoal to be brought 300 miles.

There are large supplies of flux available on the Coast, including large and valuable deposits of magnesite, situated so that the cost of transportation is very low.

The price of coal seems to make the question of the coke supply rather a serious one, but it will be seen on looking at page 13 of the Atlas of Canada, prepared by the Department of the Interior, 1915, that coal is in many cases very near to where the iron is found, and in cases where it is not, there is an abundance of coking coal at or near the sea. There are other coals on the mainland not far from the Coast which are richer in by-products. If by-product coking were developed at the Coast, it would probably pay to freight these interior coals and so obtain a higher grade of coke at a reduced cost.

There is also the water power to be taken into consideration, especially in regard to the development of electro-thermic smelting to which particular reference was made by the Dominions Royal Commission in their report on the establishment of an iron industry in British Columbia which will be found on page 38 of this Bulletin. And here it may be well to quote the following reference to electric smelting from the Monthly Commercial Letter issued by the Canadian Bank of Commerce in December, 1917, in dealing with the output of pig iron in Canada:

"For the nine months of the current year, it is interesting to note that 9,983 tons were produced in electric furnaces. The steel produced in electric furnaces during the same period was 30,960 tons, as compared with 19,639 tons during the whole of 1916. By September the production of the electric furnaces had risen to 5,000 tons per month, or at the rate of 60,000 tons per annum."

The water powers of British Columbia, which offer natural high heads are at present developed to the extent of 230,000 horse-power. Mr. Conway estimates that there is 750,000 horse-power still undeveloped within reasonable distance of the cities of Vancouver and Victoria, and outside of this area he makes a rough estimate of the water power possibilities which would bring the figures for the Province up to 3,000,000 horse-power.

As to the importation of Chinese pig iron, on which subject the opinion of Mr. Schwab and others will be found quoted in this Bulletin, this argument cannot now be used so successfully against the development of the industry here, as the shortage of ships would prevent bringing it in in any quantity at the present time, and in future the demand for it in Japan, which country has a hold on the largest producing properties in China, would render the supply to other countries more or less uncertain.

Some of the information contained in this bulletin will be found to be duplicated, as there are reports on the same properties by different authorities, and on the other hand it is quite possible that there are iron-ore deposits that are not mentioned at all, or only referred to in the reports prepared by the Mining Committee of the Board of Trade, for, as Mr. Nichol Thompson says in his address, the Government reports are not up-to-date, and one of the chief reasons for the present publication is to show the necessity for some reliable means being taken to determine the value and extent of these deposits. Since Mr. Nichol Thompson delivered his address the British Columbia Legislature has met, and the following announcement was made in the speech from the Throne (7th of February.)

"My Government is securing the services of an expert to advise on the electro-thermic treatment of iron ores, and measures for the encouragement of iron and steel industries will be presented for your consideration."

To give a general idea of the contents of this Bulletin a brief summary follows, and a reference to the Index will enable the reader to obtain more definite information on any particular point.

In Part I. we have the reports of Messrs. Lindeman, Bolton, Brewer, Galloway and McKenzie. We find that 65,000 tons of iron ore have been produced in B. C. but nothing since 1907, when 2,500 tons was shipped. Practically all this ore was magnetite, and it nearly all went to Irondale, Washington. The opinion arrived at is that it was a lack of market rather than a lack of ore that accounted for this small production. While the different varieties of iron ore are found in B. C. the most important is magnetite, but sufficient work has not been done to determine the extent of the deposits or their mineralogical composition at depth. But making allowance for the lack of development it is conceded that there is a sufficiently large tonnage available to support a small local iron industry, and little doubt that exploration would disclose many bodies of iron ore at present unknown. Mr. Brewer gives the tonnage of actual, probable and possible ore on Vancouver and Texada Islands as 12,888,20. It is agreed that the fuel and flux are obtainable within easy reach of each other and close to navigable water, ensuring cheap transportation all the year round.

Some reference is made to the competition of Chinese pig iron, but under present circumstances, and probably in the future, this can be ignored, as has been explained in an earlier part of this preface. Figures as to costs are given which would have to be revised under present conditions, but so would the price of the manufactured article. There are also reports on hematite and limonite deposits with remarks as to transportation facilities.

Part II. shows the situation in regard to the Iron Industry in 1914 as reviewed by the Minister of Mines in his annual report, and the steps taken by the Vancouver Board of Trade commencing early in that year to promote a revival of the industry. Reports were prepared by the Mining Committee, and interviews were had with Sir Richard McBride and Hon. Lorne Campbell, and considerable correspondence was carried on. The Hon. Lorne Campbell when Minister of Mines, had the Bulletin prepared by Mr. Brewer which is extensively quoted from in Part I.

Part III. consists of extracts from the Fifth Interim Report and the Final Report of the Dominions Royal Commission which deal with the iron industry in British Columbia. Notes taken from various sources have been added where it was thought they would prove of assistance and add further information.

In conclusion, this Bulletin may be, as Mr. Nichol Thompson suggests in his address, merely a compilation of varied opinions, none of which are of much use to anyone wishing to invest in the iron and steel business in our Province, yet the information it does contain may be found of sufficient importance to make it worth while to learn more, for, to quote from the report of the Dominions Royal Commission, "The opinion is strongly held in many quarters that the time has come for the establishment of an iron and steel industry, and this is a most natural and praiseworthy desire, which we all hope to see fulfilled."

IRON IN BRITISH COLUMBIA.

PART I.—REPORTS OF GOVERNMENT ENGINEERS

Up to the present the production of iron ore in British Columbia has been an almost negligible quantity. The total recorded from 1886 to 1903, both years inclusive, was only 62,578 tons; since 1903 the only production recorded was in 1917, when 2,500 tons were shipped.

Most of the ore—practically all magnetite—was sent to Irondale, Washington, U. S. A., where it was used in the production of pig-iron in a small charcoal blast furnace. The balance went to lead smelters to be used as flux.

The small production of British Columbia has been due, not so much to the lack of iron ore deposits, as to the lack of market for the ore. In the absence of a local iron smelting industry, there has been no particular incentive either to develop the known ore bodies, or to search for new ones.

The different varieties of iron ore found in British Columbia include magnetites, hematites, limonites or bog ores, and clay ironstones.

MAGNETITE.—The most important of the known ore bodies are a series of magnetite deposits which occur on the islands along the coast in the western part of the Province. Among the better known localities in which these are found may be mentioned: Gordon River, Head Bay, Klaanch River, and Quinsam River, in Vancouver Island; Louise and Moresby Islands, in the Queen Charlotte group; Texada Islands; and Redonda Island. Promising deposits are also reported as occurring on other islands, and various points on the coast, but little definite information is available regarding them. In general character all these deposits agree closely. The iron content is variable, ranging from 45 to 65 per cent. Phosphorus is often below the Bessemer limit; on the other hand sulphur is usually so high that the ore would require preliminary roasting, to render it suitable for economic smelting. Mining operations have not been extensive enough to determine their vertical shape and extent, or their mineralogical composition at depth.

Making due allowance, however, for lack of development, and for all doubtful and uncertain factors, it is still possible to say that there is in the aggregate, in the known magnetite deposits of the coast district of British Columbia, a sufficiently large tonnage of ore available to support a small local iron industry for many years when conditions justify its establishment. There is little doubt, also, that active exploration would disclose many bodies of iron ore at present unknown.

The coast magnetites, while somewhat handicapped by their composition, and while they will in most if not all cases require to be roasted before smelting, are capable of producing a good merchantable pig-iron. They can be easily and cheaply mined, and are located close to tide water. Besides an adequate supply of suitable ore, other important considerations in the establishment of an iron industry are the proximity of fuel and flux, the ease with which the raw material can be assembled at the point of production, and a market for the product at profitable prices. On the British Columbia coast, ore, coke and limestone suitable for flux are all obtainable within easy reach of each other, and all are located so close to navigable water, open the year round, that transportation would be of the cheapest. These considerations suggest that the ores will ultimately be smelted locally; on the other hand, the labor situation in British Columbia is not the most favorable.

Failure to establish an iron smelter in the past has usually been ascribed to the lack of sufficient market for pig-iron; it is possible that the real limitation to the smelting of these ores locally will be found to be the cheapness with which Chinese and Indian pig-iron can be laid down in the coast market.

The only inland deposit of magnetite in British Columbia that has had much development work done on it is the Glen Mine, on the south side of Kamloops Lake. Previous to 1901, some 12,900 tons of magnetite were mined and shipped from this property to be used as a flux by lead smelters. Judging by the available records of analyses the ore is of excellent quality, and while development is not sufficient to prove the reserve tonnage claimed (8,000,000 tons)) there is apparently a considerable quantity available.

HEMATITE.—Deposits have been found in a number of localities in British Columbia, notably, Bull River, Kitchener and Chilcotin; but, while analyses indicate some ores of good quality, there is, as yet, no evidence that they are representative of bodies of sufficient size to be of commercial importance.

LIMONITE AND BOG ORES are found at Quatsino Sound on Vancouver Island, on the headwaters of Summit Creek in the Omenica Mining Division, on Lamb Creek, and at various points in the Lillooet Mining Division. The more promising of these are the deposits at Summit Creek, and at Quatsino Sound.

At Summit Creek the ore, a comparatively pure limonite, is of good grade, and should be especially valuable for mixing with the dense coast magnetites in the blast furnaces. The full extent of the deposit is not known, but it is evidently large. At present it is too far from transportation to be available; the distance to Copper City on the Grand Trunk Pacific Railway being about 38 miles.

The limonite and bog ore deposits found at Quatsino Sound, while they have large areal extent, vary greatly in thickness, and appear, on the average, to be shallow. In 1907 an attempt was made to mine the ore on one of the most promising properties, and about 1,500 tons were shipped. The average thickness of ore over the area worked was found, however, to be only about 24 inches, and the yield too small to be profitable.

CLAY IRONSTONE occurs to a limited extent, associated with the coal deposits of Vancouver Island, but has not yet been reported in such quantity as to make it a profitable source of iron. It is also found associated with the coal deposits in the Queen Charlotte Islands, but in the undeveloped condition of these properties, it is impossible to form any idea of the quantity that might ultimately become available. (Iron Ore Occurrences in Canada, Lindeman and Bolton, Ottawa, Mines Branch, 1917.)

With the rapid development of the West, the proposal has frequently been made to establish an iron industry on the Pacific Coast, instead of importing iron products from the east. An attempt to accomplish this was made in 1880, when a small blast furnace was erected at Irondale, in the State of Washington, for the manufacture of pig-iron. "It had a daily capacity of ten tons, and was a "hot-blast charcoal furnace. It was operated for six months, and then was replaced by a 50-ton furnace, which, a few months later, was reconstructed, and for years turned out a good grade of pig-iron, until, in 1891, it was closed down. In 1901 Pennsylvania capital was interested in it. The Pacific Coast Company was organized to acquire and operate it. The plant was modernized, and about $100,000 was expended on it, and in December, 1901, the manufacture of pig-iron was resumed. Ores from Texada Island, and from Hamilton, Skagit County, Washington, were used, mixed in the proportion of 700 tons of Texada ore to 50 tons of Hamilton ore. The Texada ore was arranged in large heaps, and roasted to get rid of the sulphur, and also to render it porous, to facilitate reduction. The principal flux was limestone, and the chief fuel was charcoal, with a little coke from Cokedale, in Skagit County. Castings were made three times a day. The pig-iron was sold to the various foundries around Puget Sound, Oregon and British Columbia."

As the attempt did not meet with success, the plant was soon shut down. This fact has not had a deterring effect; on the contrary, new efforts have, during the past year, been made to re-open the works, and the possibility of this American iron industry resuming has stimulated prospecting for iron ore on the coast of British Columbia.

On account of the great percentage of ash in the coke—say 15 per cent.—the amount of coke required to melt a ton of pig-iron may be estimated at 1¼ tons. With coke at $6 per ton the cost of fuel would therefore, amount to about $7.50 per ton of pig iron.

To be on the safe side, let us estimate the iron content of the magnetites at say, 55 per cent. It will then take about 1.8 tons of ore to make one ton of pig iron. Assuming the cost of roasted magnetite at the furnace at $2.50 per ton, including in this figure 50 cents as royalty to the mine owner, then the cost of ore per ton of pig iron will be $4.50. The cost of lime per ton of pig-iron may be estimated at 50 cents. The cost of labor is higher in British Columbia than in other Provinces of the Dominion. Assuming a furnace capacity of 150 tons per 24 hours, and a production of two tons of pig-iron per man employed, at $3.50 per day, the cost of labor will be $1.75 per ton pig-iron. The following is the approximate cost, based on the above figures:

Ore (magnetite 55 per cent. iron) 1.8 tons at $2.50 per ton	$ 4.50
Coke 1.25 tons at $6 per ton	7.50
Lime	0.50
Labor at $3.50 per day	1.75

Steam raising for blowing engine	0.15
Miscellaneous materials, repairs, maintenance, general expenses, and amortization (machinery and buildings) say	1.60
Total	$16.00

Iron Ore Deposits of Vancouver and Texada Islands, British Columbia, Einar Lindeman, M. E., Ottawa, Mines Branch, 1910.)

Extracts from a report on the Occurrences of Iron-ore Deposits on Vancouver and Texada Islands, B. C., by W. M. Brewer, M.E., after an examination made during the summer of 1916.

INTRODUCTORY NOTE.

The examinations made by the writer during the past season were undertaken principally for the purpose of bringing the information regarding the iron ores already in the possession of the Bureau of Mines up-to date. During the past summer the writer was heavily handicapped, owing to the fact that because there has been no movement to create a demand for either iron-ore mines or the ore, the prospectors and other owners of deposits that had been staked several years ago had suspended development work after having acquired Crown grants for their claims. Owing to this fact the trails to the workings and outcroppings have been neglected; the underbrush, devil's club, huckleberry, salmon berry, and salal bushes have reached such great growth that the old trails were mostly found to be impassable, dumps of ore, as well as outcroppings were covered up, and the entrances to tunnels were only found with great difficulty, consequently considerably more time was occupied in making the examinations than otherwise would have been the case. In addition to such difficulties, the absence of the owners from most of the properties examined often presented such an obstacle as to seriously impede the work of examination.

Until about 1907 considerable prospecting and some development work was done in various portions of Vancouver Island and at a few points on the mainland of British Columbia by various prospectors and companies in searching for other deposits of iron ore, but since then the interest has waned until the present time.

The most serious efforts to develop the iron industry on this portion of the Coast and utilize British Columbia ore were made by the late Homer Swaney, who was unfortunately drowned about 1904 in the wreck of the steamship "Clallam" when he had practically carried his negotiations to the point where he was promised the necessary financial assistance to attempt to place the industry of iron and steel making on a commercial basis.

After the death of Mr. Swaney other attempts were made to establish the industry by using iron ore from Vancouver Island and smelting it in the State of Washington; the most notable by the Irondale Iron and Steel Company, which resulted in failure principally owing to commercial reasons.

No blastfurnace has yet been built in British Columbia, although the advisability of doing so has been very freely discussed.

TONNAGE.—From the writer's observations and examinations of the surface showings and the development work on the various mineral claims examined by him for iron ore during 1916, he concludes that, so far as quantity of ore available for mining is concerned, it is only possible to make a very rough estimate. Under the present conditions even that estimate can only be made on theory, and much more development must be done to prove the figures, which may be considerably increased, given in the following report. The development work is not sufficient in any instance to determine the conditions beyond a shallow depth, as regards the continuity of the magnetite deposits to deep levels. The same statement applies to the question of the superficial extent, because, except in a few cases, the boundaries of the deposits are not exposed. It is evident that in several instances the workings underground show that the ore-body is still strong at the lowest level reached, but that is only a shallow depth.

The writer has attempted to make an estimate of tonnage of ore available by dividing it into three classes as follows:

(1) ACTUAL ORE, meaning thereby such quantity as development has exposed sufficiently to be considered as measurable and immediately available.

(2) PROBABLE ORE, meaning such ore as is only partially developed, not sufficiently so to admit of definite measurement, but of the occurrence of which the indications are sufficiently strong to warrant an assumption that such ore probably occurs.

(3) POSSIBLE ORE, meaning such ore as is undeveloped, but which may possibly and is hoped to be found by further prospecting and development, the only indications of which are surface outcrops, and which may be postulated as possible from a knowledge of the geological conditions.

Name of Property	Actual Ore	Probable ore	Possible ore	Total
	Tons	Tons	Tons	Tons
*Ralph	......	......	......	....
*Rose	......	......	......	....
Baden Powell and Little Bobs	......	500,000	250,000	750,000
Sirdar	94,000	......	47,000	141,000
Conqueror	16,000	230,000	120,000	366,000
Sarita (Provincial Mineralogist's estimate)	......	30,000	25,000	55,000
Henderson Lake	20,000	......	280,000	300,000
Black Prince	15,000	......	15,000	30,000
Crown Prince	75,000	......	200,000	275,000
Glengarry and Stormont				
Fido (Nootka Sound)	......	50,000	200,000	250,000
(Nootka Sound)	250,000	250,000	750,000	1,250,000
Quinsam Lake Iron Syndicate	......	......	5,000,000	5,000,000
Prescott (McConnell's estimate)	......	1,366 400	993,600	2,360,000
Paxton (McConnell's estimate)	......	1,607,200	......	1,607,200
Lake (McConnell's estimate)	......	504,000	......	504,000
*Klaanch River	......	......	......	..
TOTALS	470,000	4,537,600	7,880,600	12,888,200

Note.—Properties marked * are in such condition that no estimate can [illegible]

Prospecting with diamond drills should be carried on quite extensively preparatory to the installation of any manufacturing plants.

HEMATITE AND LIMONITE.—In connection with the foregoing description of the occurrences of magnetite on Vancouver and Texada Islands, it is considered advisable to publish the report by J. D. Galloway, Assistant Mineralogist, on the occurrence of haematite iron ore on a branch of the Klinaklini River, in the Nanaimo Mining Division, also a report by J. D. MacKenzie. in the Summary Report for 1915 of the Geological Survey Branch, Department of Mines, on the occurrence of bog-iron ore on a branch of the Zymoetz River, in the Skeena Mining Division.

KLINAKLINI RIVER.—A deposit of haematite on a branch of the Klinaklini River, and therefore in the Nanaimo Mining Division, was staked a few years ago by Sam Colwell. Later his holdings were acquired by the Haematite Mining Company, the control of which is held by Peter Wallace and associates, of Vancouver. The property comprises thirteen claims, which are surveyed but not yet Crown-granted. Development-work has been carried on during each summer since the claims were staked; this work consists of open-cuts and a 600 foot tunnel.

The deposit of iron ore is as yet an undeveloped prospect, without much proven for or against it. There is no possibility of estimating, at the present time, any appreciable tonnage of reasonably assured ore, or even of probable ore. At no place is there more than a few tons of ore proved up. It is possible, however, that further development would reveal a continuity between the different outcrops and so show a considerable tonnage of ore.

The geographical situation of the property is such that the property, even with a large tonnage of ore proved, would be only of potential value. Iron ore could only be taken to a possible market by means of rail transportation. With this iron-deposit a very large tonnage would have to be proved before it would be worth while building a railroad for the hauling of the ore. It is, of course, possible, that in the future a railway may be built to develop the natural resources of this section, and in that case transportation would be provided for any deposit of iron ore.

ZYMOETZ RIVER.—The following is the report of J. D. Mac

Kenzie:—"The bog-iron ore property owned by the North Pacific Iron Mines, Limited", of Prince Rupert, is situated on Limonite (Summit) Creek, a tributary of the Zymoetz (Copper) River, thirty-eight miles east of Copper City, on the Skeena. It is six miles west of the summit of the Zymoetz River-Telkwa River trail and about forty miles from Telkwa. The property consists of nine claims on the north side of the creek, covering approximately 375 acres.

The largest of the deposits on the property, shown in the accompanying sketch-map, was examined by the writer and is described below. He was later informed on good authority, however, that other, smaller, similar deposits occur at higher elevations on the mountain-side, farther back from the creek, but these were not visited by him.

The deposit examined, which consists of a sheet of bog-iron ore of unknown thickness, extending from the 'moss-roots' to bed-rock, lies on the steep north side of Limonite Creek Valley. It extends from the stream itself for a distance of 1,800 feet in a straight line up the mountain-side, which rises steeply from an elevation of 2,600 feet at the stream to 3,500 feet at the upper edge of the bog-iron ore. The irregular area underlain by the limonite measures about 2,250,000 square feet (50 acres), and its greatest width is about 1,800 feet.

"Everywhere in this area yellow or brown earthy limonite may be uncovered merely by removing the moss from the surface; there is no overburden except the trees and moss growing on the limonite beneath, and this vegetation has been removed by burning in two placs, leaving large areas of the ore exposed.

"The deposit consists of bedded bog-iron ore, occuring in platy layers from 1 to 3 inches thick, lying parallel to the hillside, which here has an average slope of nearly 30 degrees. In addition to the stripping of the ore by burning, prospecting has been done by trenching and sinking numerous pits. The greatest thickness of limonite anywhere exposed is 15 feet; in two or three places 10 feet is exposed, and several cuts show 3 to 4 feet. In no place has the bottom of the sheet of ore been reached, and as no systematic attempt has been made to determine the quantity of ore present it is difficult to form any estimate of the amount available.

"The ore consists of yellow and brown earthy limonite, free from sandstone or other impurities, rather soft and of loose consistency, so that it may readily be dug with a pick or cut with an axe. The ore extracted from the large open-cuts has disintegrated on weathering to a crumbly, in part pulverulent mass, ranging in size of from a grain of powder to fragments an inch or two across. It is thoroughly saturated with water as it lies in the bed, but when dried might run about 20 cubic feet to the ton, at a guess.

"If the surface area be taken at 2,250,000 square feet, this figure would give 112,500 tons per foot of depth. An average depth of 5 feet for the deposit is almost certain; 10 feet is probable and perhaps the depth is greater. In other terms, 562,500 tons may be considered as almost certainly proven; twice that as probable, and perhaps the amount is considerably larger. The iron content is variable, ranging from about 50 to 56 per cent.

The following remarks relative to transportation facilities and other iron ore prospects, are copied from the Report of W. M. Brewer, who examined this property (Zymoetz River) during the summer of 1914.

The iron ore is excellently situated for mining, provided transportation could be obtained.

At the present time this property is handicapped by the lack of transportation, but the Grand Trunk Pacific Railway Company has had a preliminary survey made, and from that data the length of this railroad from the property to Copper City, on the main line of the Grand Trunk Pacific Railway, would be about sixty miles. The writer was informed by C. C. van Arsdol, chief engineer of the Grand Trunk Pacific Railway Company, that it was perfectly feasible to contruct a railroad through this portion of the country via the Zymoetz River route for local freight-haulage, but that there were difficulties to be surmounted which made it inadvisable to incorporate that section in a transcontinental route.

The property is very favourably situated with regard to timber for mining, fuel, and a fair supply for lumber, the varieties being hemlock and balsam, as well as some cedar. The watersupply furnished by Summit creek would be ample for all purposes, even to developing power for a plant of considerable magnitude.

Mansel Clarke, the discoverer and locator of this property, informed the writer (Wm. M. Brewer) that he had found other outcroppings of both magnetite and limonite iron ore for a distance of about nine miles in a N. 75 degree E. direction, or on the extreme summit at the headwaters of the Telkwa river, but could not find any deposits that would begin to approach in extent the body on the group of mineral claims examined. (Annual Report of the Minister of Mines, Province of British Columbia, for the year ending 31st December 1916).

PART II.

VANCOUVER BOARD OF TRADE.

"The situation in regard to iron ore remains unchanged, no material advancement having been made in the utilization of the numerous deposits throughout the Proinvce. At present there is no market in the Province for iron ore, and, as a consequence, very little development-work has been done. There are, undoubtedly, a number of iron-ore deposits in different districts which are of considerable size, and which are, as a rule, very free from injurious elements. In considering the possibility of the successful establishment of an iron and steel industry, other factors besides availability of ore are important-namely, a sufficient market for the products, a supply of fuel near by at a price comparable with what it is in the east, and a steady supply of suitable labour. (Annual Report of Minister of Mines, Province of British Columbia, for year ending 31st December, 1913.)

This was the situation in regard to iron in British Columbia, when early in 1914, the Vancouver Board of Trade took up the question of the revival of the iron industry in British Columbia, as will be seen in the following summary of the minutes, of various Reports prepared and correspondence.

At a meeting of the Mining Committee held in April 1914 a Committee was appointed to report on the establishment of a smelter or refinery, or both, and the following report was submitted to a meeting held the following month:

Vancouver, B. C.

With reference to your request for data regarding the establishment of the Iron and Steel Industry at Vancouver, I have to submit the following:

SUPPLIES OF RAW MATERIAL.—There are ample supplies of raw material in the form of magnetite ore on Texada, Nelson, Redonda and other Islands, and on the East and West Coasts of Vancouver Island.

There are supplies of Limonite ore at Quatsino, Barclay Sound, Green Lake on the P. G. & E. Railway, Chilliwack and other accessible points.

Hematite ores are reported from Bella Coola, Bute Inlet and other points, though it may be necessary to build railways over distances of 75 to 100 miles to make some of the best deposits available to transportation. The limonite and hematite are necessary for mixing with the black oxide ores. It may be safely stated that sufficient supplies of iron ores are available for the industry, in its present blast furnace adaptations. The magnetites are specially adapted to electro-metallurgical treatment, but this is as yet only applied to a limited extent, though its utilization is on the increase. Some years ago iron made from the magnetite ore on Texada Island was used in the construction of the United States battleships "Oregon" and "Nebraska" and on two Japanese warships, and the reports made on it stated that it proved of exceptional strength. Coast iron ores are low in the injurious elements—sulphur and phosphorus—but high in iron, 600 tons smelted at the Puget Sound Iron Company's furnace at Irondale having averaged 65.71 per cent. iron. Some Vancouver Island ores are high in sulphur and would require roasting before smelting.

COKE.—It has been stated that Vancouver Island coals are unsuitable for metallurgical coke for iron and steel furnaces, but Professor Galloway of Cardiff, Wales, who investigated the prospects of the iron and steel industry for this Coast, considers a suitable coke can be secured by using regenerative, byproduct retort ovens, for the manufacture of the coke, by which means not only can a suitable coke be secured but the byproducts of the coal would be saved and utilized, the gas making a valuable asset for power and smelting, and the sulphate of ammonia making a valuable and readily marketable product, as would also the tar, and such other products as it might be considered profitable to save and market as toluol, petrol, carbolic acid, carbolineum, etc. The market price for Coast coke is at present $5 to $6 per ton, but with byproduct furnaces it should be produced at a cost of considerably less.

LIMESTONE used for fluxing the ore, can be obtained of first class quality for the purpose at Texada and other Islands, and on the East and West Coasts of Vancouver Island. As a matter of fact it is invariably associated with the deposits of iron ore.

COST OF PRODUCTION.—A. B. Willmott estimated the cost of producing pig on the Coast at $15 per ton, in a comparatively small furnace, such as one of 300 tons.

Professor Galloway places the cost at $17.35 per ton in view of the higher wages prevailing here, and allowing for the higher cost of coke, but he says that by the adoption of the Swedish process, using charcoal as fuel, pig iron should be produced here for $12.53.

My own view is that Mr. Willmott's figures are more likely to be right as he is well posted on the actual costs at Sault Ste. Marie, and it is probable that by the byproduct process suggested, coke could be produced at a cost of about $3.50 per ton, as the waste or unmarketable coal can be utilized for the manufacture of coke, and he has allowed an increase of 33 per cent. for labour over the cost in Ontario.

THE MARKET.—British Columbia should be able to command the market for pig iron, steel billets, steel rails, car material, merchant bar and structural shapes in this Province as well as in Alberta and perhaps Saskatchewan, and as there is only a 150 ton electric plant operating in California this market could be extended to the adjacent States in spite of the duty of $2.50 per ton. The market now open to local manufacture may safely be placed at 150,000 tons a year at an average of $25 per ton.

FINANCIAL ASSISTANCE:—The Provincial Government has stated its willingness to make a rebate of the tax on coal used for manufacture of coke for a steel plant, and it has been suggested that it subsidize the industry with a bonus per ton to start with as is done in Ontario. In fact in recent negotiations with the Government for the establishment of such a plant a guarantee of bonds was seriously discussed.

ESTIMATED PROFITS:—The estimated profits on the cost estimated above given by Mr. Willmott amount to $5 per ton on pig iron and $10 per ton on rails, and with the output from a furnace of 300 tons a day, working up part of the product into billets and steel rails, it is estimated a profit of $700,000 a year could be made.

GENERAL NOTES:—There are no known deposits of iron ore of commercial value on the northern Pacific Coast south of British Columbia.

A Company entering the iron and steel business should own the coal fields necessary to supply it with coal for its byproducts coke ovens; and deposits of iron ores and limestone either purchased out-right or the rights to mining secured at as low a royalty as possible.

The coal in the Comox field is reputed to be the best coking coal on Vancouver Island; but if suitable railway rates could be secured there is no reason why the coals of Merritt and Coalmont should not meet requirements as they are good coking coals.

It has been suggested that a particularly good coke can be obtained by mixing Comox and Nanaimo coals.

One important advantage of a Company owning its coal field is that it can market its higher grades of coal to the public at good prices and use the lower grades for coking, fine coal making the best coke.

If you place the cost of pig iron at $15 per ton you will be on the safe side. The Western Steel Corporation claimed the cost of production at Irondale was $13.07 per ton.

Experts believe that, with the proximity of iron, coal and limestone on the Coast, the industry, when established, could be operated on the Coast as economically as in the East where these raw materials have to be transported long distances.

The freight rate on pig iron from Chicago to Coast points is $15.00, and on structural steel $18.00, so that the local works would have the advantage of these rates over the imported article.

The rate via the Panama Canal is placed at $5 per ton, which represents the advantage of the local manufacturer over the best possible rates expected on Eastern competition, or 25 per cent. on the estimated cost of producing pig iron locally.

Steel rails delivered at Vancouver now cost $22 per ton.

A nail industry in Vancouver absorbs 4000 tons of iron per annum.

Car works established here could, on a high railway authority, find a market for 30 box cars a day, each car absorbing in car wheels axles, journals, forgings, bolts and rods 1½ tons of iron.

The rail market of B. C. for new tracks and renewals is about 40,000 tons a year.

The advent of the Yarrow Shipbuilding Firm means a new and increasing demand for iron and steel here for shipbuilding.

In locating a site for such works is should be borne in mind that 4 tons of raw material are required to one ton of finished product.

Cheap land is an important requisite in keeping down the capitalisation and allowing the Company an income from the sale or lease of the land occupied by its employees and any business enterprises that might be established in the vicinity.

ADVANTAGES OF VANCOUVER as a site for such works are:

It is the commercial metropolis.

Two transcontinental roads enter it and three more propose to do so.

Manufacturing industries likely to be consumers of pig iron and steel are more likely to locate at Vancouver than at any other point, and this City must be looked upon as the largest market for finished products.

It is equi-distant from the points from which the supplies of raw material might be drawn.

It would form the best market for the by-products.

The lowest price at which British pig is likely to be sold in Vancouver is $21 a ton made up as follows:

British Home Price	$12.00	per ton
Freight and Charges	7.50	
Duty	1.50	
	$21.00	

Pig iron made in Vancouver could be sold at $20 per ton, which would allow an estimated profit of $5.00 per ton.

Steel billets can be produced at $24 a ton, and might be sold at $30.00, giving a profit of $6 per ton.

Steel rails can be produced for $25 a ton and can be sold at $35, giving a profit of $10 per ton.

The following estimate of market and profits was made by the experts of an Eastern manufacturing firm after investigating conditions here:

Now we have the Coughlan and other firms building steel ships in addition to Yarrows

	Tons	Profits per ton	Total Profits
Pig Iron	13,000	$5.00	$65,000
Steel Billets	8,000	6.00	48,000
Rails	39,000	10.00	390,000
Car Wheels and other Castings	39,000	5.00	195,000
	99,000		$698,000

I am advised that a plant to make the suggested output of 300 tons a day would cost $600,000.00, but my own opinion is that at least $1,000,000.00 should be provided to start with, and the plant could be increased as the growth of the business warrants.

IRON ORE SUPPLY.—There is undoubtedly abundance of iron ore easily accessible at the Coast, generally speaking, this is of the magnetite variety, which, while not prohibitive in modern metallurgy is less desirable than the softer hematites, chiefly by reason of the rapid destruction of frunace linings, etc. For lessening this evil, there are, however, hematites and limonites available at points not remote from the Coast and that can be made readily accessible. Hematite proper is indicated in quantity and of excellent quality, through a belt of country extending Northwest from Chilco Lake towards Bella Coola. Transportation for this may be provided at a cost not unreasonable, if conditions demand. The brown hematite or limonite, a hydrous exide of lower iron tenor, is found in the same neighborhood, but also more accessible near Nicola—tributary to the P. G. & E. Railway, now under construction, and elsewhere as on Quatsino Sound.

But the magnetite is the one that will be easily available to shipping, and of low cost, and will undoubtedly furnish the bulk of the ore supply. I propose to demonstrate that this variety in itself may be counted on to meet all requirements.

Magnetite occurs in more or less quantity at various points on the Coast—notably on Texada Island, where a large tonnage has been mined, and shipped while the plant at Irondale, Wash., was in operation. This property has never been drilled and has only been proved at depth of one point by a crosscut tunnel penetrating for 75 feet, but not completely crosscutting the ore at 700 feet depth. There is a tonnage which has been estimated at 4,521,200. The quality is good except at points near the contact where sulphur occurs abnormally and often associated with copper. A clean high grade magnetite may be mined and delivered to barges or bunkers at a very low cost indeed with good equipment probably less than 60c per ton.

Aside from this are bodies of magnetite more or less extensive and of good quality on Redonda Island, at Seymour Arm, on Louise Island and Moresby Island of the Queen Charlotte group. The first mentioned has not been extensively proved, but is believed to be small, though of excellent quality; the second at Seymour Arm, though undeveloped, is said to promise quantity. Louise Island has indications of large body of excellent quality, so far as one may judge from surface stripping. On Tassoo Harbour, Moresby Island, there is evidence of considerable quantity of good quality, besides vast bodies that carry sulphur associated with copper. In addition to this, there are many occurrences at Bug-a-boo Creek, South Western Vancouver Island, Fanny Bay, Phillips Arm, on Pitt and Porcher Island and elsewhere. The latter occur along the shore of Granville Channel and can hardly be counted on at present for the reasons that they will, if required to produce large tonnage, be mined below sea-level and through large areas along the strike will require concentration.

Such ores as carry a high percentage of iron associated with copper in small quantities are, I believe, destined to play a very important part in the iron ore supply of this Coast, for the reason that they are susceptible to a magnetic separation which will make two valuable products with no waste, first a very high grade magnetite and second, but propably of equal importance when the copper content is fair—a basic copper concentrate, carrying from 5% to 10% copper. The magnetite concentrate, which may be so graded as to carry 66 to 70% iron, is prepared for the blast furnace by sintering, whereby a product is obtained inferior in no respect, and possibly superior to hematite. (See article on the subject by Jas. B. Klugh in transactions of the American Institute of Mining Engineers for 1912.)

The plant for magnetic concentration and sintering is not a costly one, the cost of operation is low. At Birdsboro, Pa., such a plant has been in successful operation for three years with marked efficiency. At

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*Texada Island, B. C., R. G. McConnell, Page 58

Lebanon, Pa., they are treating an ore that carries 40% iron as magnetite with 0.5% copper in a silicious gangue. This is subjected to magnetic separation by the Grondal method; the magnetic portion or heads are sintered for the blast furnace by the Greenawalt system, and the non-magnetic, or tails, are concentrated by water for their copper. At Moose Mountain in Western Ontario, a Grondal plant has been installed to separate clean magnetite from an ore carrying excessive sulphur as pyrite. Sintering practically eliminates the small quantity of sulphur which may be carried.

Sintering by the Dwight-Lloyd and the Greenawalt process differs only in the apparatus—the principle is the same. The former is continuous and uses a travelling belt which is herring bone grate and forms the cover to a suction wind box. Ore mixed with pulverized coal and well moistened is fed on this belt to a suitable depth, and is ignited by a powerful oil burner. In brief time, it is discharged from the end of the belt, and drops in masses of material, which is a mixture of the higher oxides with some iron in metallic form, reduced by the carbon of the coal. This is a most desirable ingredient for the blast furnace and will mix well with magnetite.

The Greenawalt system is intermittent, using a tray which covers with grating a wind box. When the ignition is complete, this tray is lifted and dumped, breaking up in the process to suitable size for the furnace.

Magnetite ores carrying copper in the form of chalcopyrite occur in various localities on the Coast, and seem to offer an attractive field for investment when conditions are favourable. Such a deposit is being opened up at Tassoo Harbour, ideally situated for economical operation and for transport. Since March 20th, 760 tons have been shipped from this property which analyzed approximately 62% iron, 2% copper, 4% silica, 1% lime and 2.7% sulphur. While not developed to a great extent, there is every indication of a vast tonnage with a similar iron context and from 1½ to 2% copper. Tests have been made at the Mines Branch of the Dominion Department of Mines at Ottawa and are being made by the American Grondal Co. at New York. While detailed reports are not yet in, the latter reports that there are no obstacles to an efficient separation, and the former states that the result of a test made gave magnetic concentrate of 68% iron, with traces of copper and non-magnetic 25% iron, 9.5% copper. The latter will carry the silver and gold which on 1½% copper, will amount to $0.50 or better, and on 9% probably $3 to $4 per ton.

I am strongly of the opinion that a high grade sintered magnetite may be produced from such ores in quantity to meet all requirements for admixture with magnetite for the iron blast furnace; and I should put its cost f.o.b. smelter at about 7½c per unit or say, $5.00 per ton for 66% iron. As magnetite carrying in excess of 60% iron may be counted on to yield a good mining profit at about $2.50 per ton f.o.b. smelter, the iron supply of a blast furnace at the Coast should be procured for $3.25 to $3.75 per ton for 63% iron, which is from one to two dollars less than the market price on the Eastern seaboard.

HANDICAPS.—The handicaps to an iron smelting plant on this Coast that carry most weight in argument are—lack of metallurgical fuel of suitable quality and cost, and the unreliability of the labour market.

As to fuel— the fact that good coke has not heretofore been made on Vancouver Island is no reason why it cannot be made. When Dunsmuir was producing under contract for the Tyee Smelter, it was done in the crudest nammer—coke was supplied—regardless of quality.

Mr. Galloway has expressed unqualified opinion that excellent metallurgical coke may be produced from Vancouver Island coals. Of one thing I am confident, that whatever the source, coal suitably washed to produce a high grade coke can be laid down at the Coast and there coked in by-product ovens. Not only the by-products, but the waste heat may thus be utilized and coke to the blast furnace cheapened. The best coal will be the cheapest, and may even be brought from the Crows Nest collieries, if no nearer source is found.

A market for byproducts will have to be made. The market value if a demand can be created, is high. At the present time, it is of course impossible to estimate at what price coke may be produced, taking credit for by-products marketed. If we assume it to be about $4.00 per ton, which seems not unreasonable, the cost of pig iron will figure out approximately as follows:

1.6 tons iron ore at $3.50	$5.60
1.25 tons coke at $4.00	5.00
Limestone	.50
Labour	1.50
Interest and Depreciation	1.00
Sundries	.40
Cost per ton of pig	$14.00

In a letter to Sir Richard McBride, the Minister of Mines for the Province of British Columbia, dated the 16th of September, 1915, it was suggested that more attention should be given to the development of the Iron resources of the Province and some asssitance given for the establishment of blast furnaces and mills here, to which Sir Richard replied that "Iron manufacture in British Columbia has been thoroughly investigated by the Department, and has been fully discussed in various reports. When a bone fide practical proposition is laid before it, the Government is prepared to consider what steps can be taken to give encouragement. As you are aware, throughout Canada the iron industry is encouraged by bonuses by the Federal Government and not by the Provinces."* (In re bonuses—On December 31, 1910 the bounty for pig iron ceased, excepting for that produced from Canadian ore by the electric process. No claim has, however, yet been made for pig iron produced in this manner. Canada Year Book, 1915, p. 459. And also when the Port Arthur Board of Trade asked Vancouver for its support for a 50c per ton bounty to be placed on each ton of Canadian Iron ore mined and smelted during the next ten years, the Mining Committee through the Board recommended that it could not endorse such a recommendation as the placing of such a bounty would benefit only the East and would likely bar the establishment in this Province of blast furnaces for the manufacture of pig iron.)

In October 1915 a further Report on the Iron and Steel industry was submitted by the Mining Committee to the full Board and adopted and the report reads as follows:

"We believe that the time has come when energetic steps should be taken to establish an iron and steel industry in this Province, and in support of this we beg to submit the following information:

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*[illegible] Steel from 1884 [illegible] 1912 $17 [illegible]

"British Columbia imported in 1912 approximately 120,000 long tons of iron and steel, having a gross value of approximately $2,000,000.00. This Province has abundant supplies of raw material for the manufacture of all the iron and steel required for British Columbia, and the adjacent provinces and states, there being no iron and steel works on the Pacific Coast between Alaska and Mexico, and west of the Rockies, so that the industry established here would have this field for its market. The Committee has information that the Russian market will be of great importance in the developing of the export trade in iron and steel.

"In a paper read before the American Institute of Mining Engineers, Mr. C. C. Jones stated that the ores of this Coast carry from four to ten per cent more iron than the standard Lake Superior iron ores, that the bulk of the tonnage is within Bessemer limit for phosphorus, and there is no cost of drying before transportation, thus saving ten per cent on the freight charged on Lake Superior ores. He estimates the present market for iron and steel products on the Pacific Coast to be 923,000 tons per annum, and states that if cast iron pipe, oil pipe, railway steel and shipbuilding are undertaken the amount of iron and steel required will be approximately 2,000,000 tons per annum. He points out that the cost of iron ore delivered on the Coast will amount to $3.50 to $4.50 per ton, as against $8.17, the present cost of Lake Superior ores delivered at the Eastern works.

The cost of producing pig iron in British Columbia has been estimated by Dr. Lindeman at $16.00 per ton, by Seaver at $12.25 per ton; and by Wilmot at $12.00 to $17.00 per ton, according to quality. The cost of producing pig iron at Irondale, Washington, is $13.75 per ton. The average cost of pig iron at Pittsburg is $15.30 per ton, as given by Judge Gary before the Steel Commission of the United States. The present cost of United States pig iron in Vancouver is $27.50 per ton, and of Eglinton (England) $33.00 per ton. The price of this, under normal conditions, would be $22.50 and $27.00 per ton respectively.

"The cost of a one hundred ton per day unit blast furnace, including rolling mill, converting plant and coking plant would be approximately $1,800,000.00.

"In our opinion a steel plant capable of supplying the local market and the immediate export trade could be put down here at a capital of approximately $5,000,000.00, and we recommend that the Provincial Government be approached to assist in some tangible way any bona fide company that would establish such a plant here.

"While the Committee is fully alive to the importance of establishing an iron and steel industry in British Columbia, we do not feel justified in recommending that the Board endorse any particular corporation, or scheme."

During the month a letter was received from Sir Richard McBride in which the reference to the iron industry already quoted appears and in their reply the Committee said that they "think the time has arrived when the Province should act independently of the Dominion in the development of their most important industry" and further stated that "it is the aim of this Committee to assist the Government in arriving at a practical solution of a problem which means so much to the Province." In January 1916, at a meeting of the Mining Committee, the appointment of Hon. Lorne Campbell as the new Minister of Mines was discussed and it was decided to take up with him the question of the iron and steel industry, and a sub-committee was appointed to compile and tabulate a statement showing all the iron, coal and water power in use in British Columbia, as well as any bona fide prospects dealing with the above natural resources, and a resolution was passed requesting the Government to establish smelting and refining facilities on this Coast. This Report was submitted to a meeting held in February, and it was resolved that a copy should be sent to the Minister of Mines, and further that, in view of the desirability of encouraging the establishment of the iron and steel industry in British Columbia and the necessity of having reliable data as to the iron ore resources available for that purpose, the Honourable the Minister of Mines be requested to have a reliable report made thereon by a competent engineer and published as soon as possible. The information in that report is compiled from the various authorities quoted in the present report.

In the month of March the new Minister of Mines replied that it was his intention to compile in bulletin form the various references to iron deposits which have from time to time appeared in the reports of his Department, but before proceeding with the compilation he hoped to have all the other available information brought up to date. The report by W. M. Brewer on the occurences of Iron ore Deposits on Vancouver and Texada Islands, which appeared in the Annual Report of the Minister of Mines for the year ending 31st December, 1916, and which has been already quoted from, was prepared in accordance with this promise.

In the early part of April a joint meeting of the Mining Committee of the Vancouver Board of Trade, the Chamber of Mines and the Industrial Committee of the Municipalities of the Lower Mainland was held, at which, among others, the subject of the development of the iron industry was taken up and it was resolved that this Committee appoint a joint Committee of the interested representatives present to confer with the Honourable the Minister of Mines as to the best means to be taken to develop the general mining industry of this Province, but the Minister of Mines was unable at that time to make an appointment to meet the delegation.

At a meeting of the Mining Committee held in the early part of January 1917, a Report was submitted for presentation to the full Board, dealing with lead, copper and other metals of the Province, making strong claims for the establishment of refineries in British Columbia. A copy of this resolution was ordered to be sent to the Honourable Sir Thomas White, Minister of Finance, and to H. H. Stevens, M.P.

PART III.

DOMINIONS ROYAL COMMISSION

Extract from the Final Report of the Royal Commission on the Natural Resources, Trade and Legislation of certain portions of His Majesty's Dominions, Feb. 12, 1917, Page 34, Para. 176, line 5:

"Large deposits of iron are known to occur in British Columbia, both on the mainland and in the Islands bordering on the coast. In our Fifth Interim Report we have dealt more in detail with the British Columbia iron ores, and have suggested certain preliminary measures towards development (see below). But it must be granted that a very large proportion of the ores consists of magnetite, and many of them are impregnated with sulphides to an extent which makes them at present unattractive to iron and steel operators."

Extract from Fifth Interim Report of above Commission, Pages 47 and 48, Para. 167.

"We next desire to deal briefly with the question of establishing an iron industry in British Columbia, since this matter was brought prominently to our attention during our stay on the Pacific Coast.

"It was represented to us that there are numerous and extensive deposits of iron ore of excellent quality throughout the Province of British Columbia, that in particular there are large deposits of magnetites in a convenient situation in relation to water power, and that there is no reason why these should not be converted electrically into high class steel as is done in Norway and Sweden with similar magnetite ores.

"The opinion is strongly held in many quarters that the time has come for the establishment of an iron and steel industry, and this is a most natural and praiseworthy desire, which we all hope to see fulfilled."

Para. 168.—"There are, however, certain factors in the question which call for very full and careful consideration before a final decision is taken. There are, for instance, the question of the proximity to each other of the ore, the coal, and the flux, if blast furnaces are to be erected, and also an adequate and steady supply of suitable labour, and the competition of pig iron from China. (Re Chinese Labour, Minutes of Evidence, Part II., Page 252, R. E. Gosnell. "In considering the iron resources of British Columbia and its commercial situation, it would be folly to overlook a factor which may be one of surprises and disconcertment in the iron fields of the Orient. There are immense iron deposits in China, which, with unlimited cheap labor and a spirit of awakening in that nation, might necessitate a reconstruction of all plans that were made without reference to that field. Chinese commercial pig and iron ores were sold to the Irondale Works until they closed down, and, together with scrap, formed the chief source of supply for the works there. Chinese pig iron was laid down at the wharf at Irondale, duty ($2.50 gross per ton) paid, ready to unload at $18.00 per ton. Chinese hematite, in lumps, was landed duty (15c per gross ton) paid, at $4.15 per ton.")

And also in reference to this question of Chinese labour we have on file a copy of a letter from C. F. Law to Sir Richard McBride, dated 9th Dec. 1915:

"We took up with Mr. Charles Schwab the matter of an Iron and Steel Smelting Plant for British Columbia. Mr. Schwab advised against it, for the reason that China pig iron could be brought in at a price below cost of pig iron production in British Columbia. He states that the Union Iron Works at San Francisco, which he controls, is now doing this and making steel billets to supply the Pacific Coast market. Mr. Thomas has therefore decided to drop further consideration of this matter on the advice of Mr. Schwab."

"With regard to the iron and steel situation here, one must admit that Mr. Schwab's expert knowledge places him in a position to speak with considerable authority."*

PARA. 168 CONTINUED:—"There is also the question of markets, but this, in the case of a high class steel which brings a high price, would settle itself.

"The question of the cost of production is, however, fundamental. We were told, but without definite evidence, that the cost of hydro-electric energy in Norway is four to five dollars per horsepower per annum, and, again without evidence, that it could be produced in the district of Vancouver at seven to eight dollars per horsepower per annum.

("In British Columbia, however, there are in many of the water-powers somewhat similar conditions to those that obtain in Scandinavian territory: i.e., powers than can be developed economically under high heads," Water Powers of Canada, Province of British Columbia, G. R. G. Conway, Page 20.) On the other hand we were told by large producers and large consumers that this suggested figure is quite impossible and that the electric energy could not be produced in British Columbia, even under the most favorable conditions as to load, at less than fifteen or twenty dollars per horsepower per annum. (In the answers to the questions asked by Colonel D. Carnegie treating with the establishment of Zinc or Copper refinery on this Coast, submitted by the Mining Committee of the Vancouver Board of Trade on 7th May, 1915, on page 3, referring to Power, Question 5, "what would be the lowest cost per horsepower year or per kilowat hour?" the answer given is from $10.00 to $24.00 per horsepower year, the latter being the outside price.)

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*Mr. Thane and his associates evidently do not agree with Mr. Schwab. See Preface

PARA. 169.—"The matter is an important one for the Province, inasmuch as the utilization of the magnetites in the manner suggested might ultimately lead to the utilization of the larger deposits of hematite not at present so accessible. It occurs to us, therefore, to suggest that it might be quite worth while for the Provincial Government to send the most competent member of their staff, who has had the best knowledge of metallurgy, to Norway to ascertain by enquiry there the similarity or otherwise of the ores of the two countries, the cost of treatment and of electric energy in Norway, and whether the alleged low cost in that country, as compared with the lowest estimate for British Columbia, is to be accounted for by anything except the lower cost of labour.

"The expense of such a mission would not be great and might be amply compensated for by resulting in benefits to the Province."

NOTES RE ELECTRO-THERMIC SMELTING.—As regards the suggestion to send a metallurgical expert to Norway, it might be pointed out that a report of the recent developments in the Electro-Thermic production of iron and steel will be found in the summary report of the Mines Branch of the Department of Mines for the year ending the 31st of December 1912, pages 107 to 120 inclusive. This report describes the investigation made by the Canadian Government of the electric furnace at Domnarfvet in 1909 and the conclusions reached by the Government's representative, and a further investigation in 1911 and

1912 on Trollhattan Furnace, which reports improvements in the process. In the second report it is stated that "this process substitutes electrical energy for about two-thirds of the fuel charge, and the prerequisite of very cheap power for the economical operation of this process becomes obvious", and the general conclusion reached is that the electric production furnace has passed the experimental stage and it is meeting the requirements in localities where it has been introduced. It is beginning to find extended application in Sweden, Italy and California, and will no doubt be introduced on a large scale wherever power is sufficiently cheap and where coke and charcoal are comparatively costly, and again in 1914 the Dominion Government sent Dr. Alfred Stansfield to investigate steel smelting furnaces in Sweden and Norway.

In the eight annual report of the Commission of Conservation, page 189, is the following: "The use of hydro-electric energy in electrochemical and metallurgical processes is generally considered the most advantageous use of water power."

And in water power of Canada, Province of B. C., G. R. G. Conway, page 20: "It is, however, in the field of electro-chemistry that some of the greatest opportunities are offered, but in the electro-chemical industries it must be borne in mind that the construction of hydro-electric plants must be carried out so as to procure electrical energy as economically as is done in large plants in Norway, Sweden and Switzerland. In British Columbia, however, there are in many of the water-powers somewhat similar conditions to those that obtain in Scandinavian territory, i.e., powers that can be developed economically under high heads."

And on pages 22 and 23: "In the field of electro-metallurgical work probably few countries in the world have greater promise for its development and the opportunities for the use of electric smelters in a country so rich in mineral resources are unbounded. The reader is referred for information on this subject to an interesting paper on 'The Electric Furnace in Metallurgical Work' published by the U. S. Bureau of Mines, as it is impossible to do more than refer to the possibilities here. The establishment of electric metallurgical refineries for copper in the neighborhood of Vancouver or Prince Rupert, where the plants could be erected on excellent water front sites at the minimum of expense, would add to the incentive already existing to develop further the great copper mines of the province. The application, too, of electric power in dealing with the rich zinc, lead and magnetite ores obviously offers a great field of expansion."

And again, on page 162 Transactions Am. Institute Mining Engineers, Vol. 50, 1914, dealing with the electric furnace, Mr. Robert M. Keeney of Pittsburg, Pa., makes the following remark:

"In this paper the writer does not advocate the production of pig steel from ore in the electric furnace as a competitor of the present method of steel production of pig iron as an intermediate step, but presents the general metallurgical side of such a process and its economical possibilities in regions where power is cheap and fuel and reducing materials are expensive as, for example, Sweden, California, British Columbia and the Western Coast of South America. When in these countries local demand for pig iron and steel is greater the electric furnace has an opportunity."

In the Board of Trade Journal, London, England, Dec. 27, 1917, Page 689, the following item appears under the heading: Minerals, Metals and Machinery, Canada. Increased use of Electric Furnaces.

"The Imperial Trade Correspondent at Toronto (Mr. F. W. Field) has forwarded under date 22nd October, a copy of the report for 1916 of the Ontario Hydro-Electric Power Commission, from which it appears that during the year under review the Commission had been investigating modern electric furnace practice. The results of investigation so far show that where power is plentiful and reasonable in price, the electric steel furnace is entirely practical.

"The increasing number of these furnaces in Ontario confirms this belief, and it is anticipated that the electric furnace will not only be applied to the production of fine steels, but that it will even compete with the open hearth furnace.

"There is also every indication that electric smelting for iron, copper and other ores will be an important factor in the mining districts of the Province. The high prices ruling for coke and coal and for steel products during 1916 made the electric furnace vere attractive, and there is every indication that electric steel production in Ontario will grow rapidly during the next year or two.

"The electrical production of such products as calcium carbide, carborundum and other substances requiring very high temperatures, is growing, and in Ontario such production will undoubtedly take an increasing share of the surplus water powers."

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